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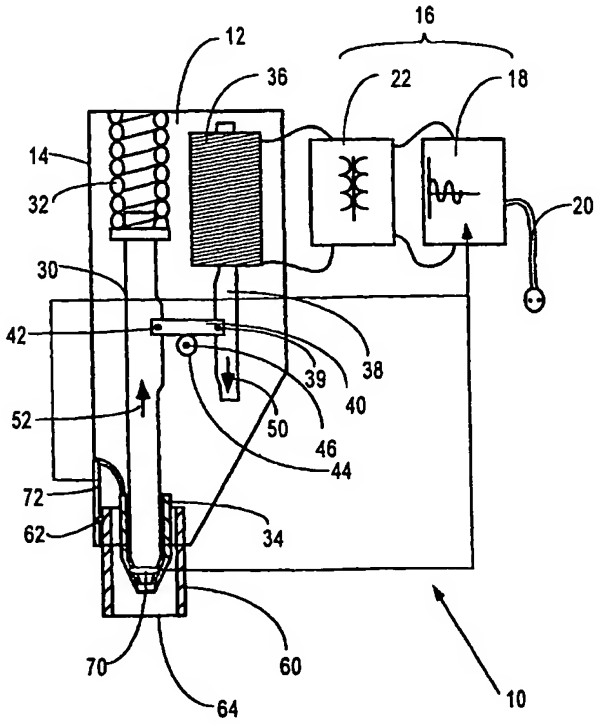
(54) Title: METHOD AND APPARATUS FOR HAIR REMOVAL

(57) Abstract: The present invention concerns a hair removal device and a hair removal method wherein the hair is gripped, and then high frequency and amplitude vibrations are transmitted to the gripped hairs.



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METHOD AND APPARATUS FOR HAIR REMOVAL

FIELD OF THE INVENTION

The present invention relates in general to hair depilatory devices and methods for removing hair.

BACKGROUND OF THE INVENTION

Various hair depilatory devices and methods are known. Wax-based preparations are used to remove body and facial hair and include both cold wax preparations, and hot wax preparations.

In recent years, a variety of electrically or manually operated hair depilation devices based on hair plucking are have been developed .

Other gripping means disclose a plurality of rotatable disks which are arranged to be bent, one or more times towards each other at a point during their revolution, which at the point they can tighten around the hair shaft and can cause it to pluck out the hair.

U.S. Patent No. 5,908,425 discloses a hand-held, manually operated depilatory device which removes hair located along a length of a linear axis. A string-like elongated element is positioned within the frame and hair is engaged and captured by the moving twisted engagement of said element and pulled away.

U.S. Patent No. 5,112,341 discloses a hair removal device having multiple-tweezers element arranged to pluck hair by the plucking motion of a set of movable twist tweezers, which work in a continuously repetitive fashion. Preferably, the hair-plucking element comprises a set of disc-shaped tweezers elements which are in a fixed position, and an interleaved set of disc-shaped movable tweezers elements mounted on a central shaft. The spaces which are formed between the

elements are repetitively opened and closed by the sliding motion of the shaft against a cam which drives the movable elements in both directions in relation to the fixed position tweezers in order to trap and pluck out hair.

EP 287 976 discloses an epilating appliance having a tweezers arrangement which opens and closes in an oscillating fashion, the tweezers arrangement oscillates in the direction of, and away from, the hand-held supporting device, so that the gripping devices are adapted to approach the skin's surface in a spread apart position for receiving the hair, and when in the proximity of the skin, the gripping devices are movable to the gripping position in which they clamp the hair, and when in the closed condition, the gripping devices withdraw away from the skin and the hair is thus being plucked out in the process. Then, in the range of the retractive position the gripping devices move again to the spread apart position in which hair is ejected and additional cycles of removal of hair may be initiated.

Most prior art depilatory devices are based on the concept of plucking out hair by a single plucking motion, i.e. gripping the hair, and pulling it away from the skin (which pulling may be abrupt or continuous) such that the hair shaft is either plucked from its roots or torn.

SUMMARY OF THE INVENTION

In accordance with the present invention, hair to be removed is subjected to vibrations at such a frequency and amplitude that they are transmitted to the hair root or to the hair supporting elements in the vicinity of the root, and exert a force or transmit energy at an extent such as to cause the root to disconnect from the surrounding tissue or at least to considerably reduce the degree of its attachment to the surrounding tissue.

The term "*disconnect*" or "*disconnection*" is used herein to denote a partial or a total impairment of the connection between the hair root, or any of the hair or hair supporting elements, and the surrounding tissue. Such disconnection is manifested in that the force required to subsequently pluck the hair out of the skin is less than that required in order to pluck the hair prior to subjecting it to vibrations

as it is done in accordance with the invention. The result of such disconnection is also manifested in that the plucking action is less painful to the individual as compared to plucking without prior vibration treatment.

The disconnection of the root results from one or combination of a direct effect of the mechanical energy transmitted to the roots or to the supporting elements, or as a result of the elevation in temperature of the root or the supporting elements which may be caused by the mechanical energy absorbed thereby. In accordance with the invention, the hair itself to be removed is used as a wave guide to transmit an amount of energy which damages the root and surrounding elements and yields the detachment of the root from the supporting elements, or the detachment of a portion of the supporting elements from the adjacent tissue.

In the following, the term "*tissue damaging force*" will be used to denote a force created by vibrations which might cause at least one of the following:

(i) a fatigue-causing effect in the hair follicle leading to partial or total disconnection of the hair root from the hair supporting element or disconnection of any of the hair supporting element from the adjacent tissue; or

(ii) production of sufficient heat to locally destroy at least one hair supporting element or the hair root.

The term "*hair supporting element*" will be used to denote a structural or physiological supporting component required to support hair and maintain its viability. Hair supporting elements, include in particular the hair follicle, the papilla, the blood supply to the hair, as well as the bulge and the small muscles attached thereto in proximity to the root. The term "*hair base*" may at times be used herein to denote collectively the hair root, hair shaft and hair supporting element.

The vibrations transmitted to the hair are at a frequency such as to allow the mechanical wave to travel along the hair and reach the hair base. This frequency is preferably such that with respect thereto the hair essentially behaves like a rigid body. The vibrations are typically in a frequency of 10 Hz to 100 kHz,

preferably in the frequency range of 50 Hz to 10 kHz, and most preferably in the range of 100 Hz to 1000 Hz. Thus, vibrations transmitted through the essentially rigid hair shaft and over a period of time which depends on the intended amount of energy to be transmitted to the hair base and which in turn may depend on a variety of factors, some of which are detailed below, reaches the hair root and/or a hair supporting element, and then either in direct consequence of the mechanical energy or as a result of heating thereby, the root or any of the hair supporting elements fatigues and disconnects from its surrounding tissue. Thereafter the hair may be free and can either fall out naturally or be easily removed. The greater effect may thus either be achieved immediately, or may be achieved after a period of time following the treatment.

The removal of hair in accordance with the invention has a number of advantageous results. For one, hair removal is less painful than removal by a single and abrupt plucking motion, as is in hitherto available depilatory devices. In addition, in accordance with the invention, a large proportion of the hair is removed with the roots, while in prior art depilatory devices, hair would very often be torn, i.e. removed without the root. Furthermore, the destructive forces on the hair root and its supporting elements often have a long-lasting effect which, in some cases, may even lead to permanent cessation of hair growth.

Thus, the present invention provides a hair removal method comprising:

(i) gripping hair to be removed;

(ii) transferring, to the gripped hair vibrations, at a frequency and amplitude, such that the vibrations are transmitted to the hair's root and exert a tissue-damaging effect in said root and/or in at least one hair supporting element.

(iii) maintaining said vibrations for a time sufficient to bring the hair's roots to disconnect from the hair supporting elements and/or to disconnect the hair supporting elements from the surrounding tissue; and

(iv) releasing the said hair.

The present invention further provides a hair removal apparatus, operating through hair removal cycles, wherein each cycle starts with gripping of hair to be removed and ends with the release of said hair, the device comprising:

(i) a hair gripping device for gripping to hair at a start of the hair removal cycle and releasing the hair at the end of a hair removal cycle; and

(ii) a vibration generator coupled to said gripping device, for transmitting vibrations to the hair through said gripping device during said cycle; said vibrations being at a frequency and amplitude such that they are transmitted to the hair's root and/or to at least one hair supporting element and to give rise thereto a tissue damaging effect.

The term *"hair removal cycle"* refers to a cycle beginning by the gripping of the hair by the hair gripping device, and ending with the release of the treated hair by the hair gripping device following the vibration transmission phase. In addition, the hair removal cycle may include other phases including tensioning the hair to be removed, stretching the surrounding skin, or plucking the hair at the end of the cycle prior to its release by the gripping device. The various steps of the hair removal cycle will be discussed in more detail below.

The hair-gripping device should be of a kind that allows tight gripping of the hair at the beginning of the hair removal cycle, and permits its release at the end of the hair removal cycle. It may have various shapes and forms and may be selected from a hair gripping means hitherto used in the art in depilatory devices and others. For example, the hair gripping device may consist of threads of rotating coil spring; may consist of pairs of rotating discs which can change their respective distance during rotation such that they grip the hair in a portion of their rotational cycle and release it in another; may consist of pairs of fingers or tweezer-like members; may consist of gripping devices arranged in a comb-like configuration, in which the teeth periodically open and close to grip and release the hair; may consist of arms which can move towards one another to close or converge into a gripping state at the start of the cycle and then move away from another to open or diverge

into a releasing state towards the end of the cycle; and others. It should be noted that the hair gripping devices may at times be endowed with only the function of gripping the hair and releasing it at the end of the hair removal cycle without plucking the hair from its root. Alternatively, the gripping device may be endowed with the function of hair plucking at the end of the hair-removal cycle.

The hair gripping device may coupled to a vibration generator such as, for example, a piezolectric device; an electro-magnet driven vibration generator; an electric, pneumatic or hydraulic eccentric motor or piston-driven vibration generator; etc. Here again, the invention is not limited to any specific vibration generator. Furthermore, it is possible at times to employ a combination of vibration generators to yield a combination vibratory wave, which may allow to generate vibrations with a pattern not possible with a single vibration generator. Any such generator or combination of generators, which may be coupled to the hair gripping device to allow transmission of vibrations at a desired amplitude and frequency therethrough to the hair may be employed in accordance with the invention. The induced vibrations may be axial, i.e. in a direction parallel to the hair's shaft (induced by rapid reciprocating movements of a gripped portion of the hair in a direction parallel to the hair's shaft), may be lateral, i.e. to the hair's shaft (induced by rapid reciprocation of a gripped portion of the hair in such a direction), or may be a combination of the two.

In accordance with a preferred embodiment, prior to inducting vibrations, the gripped hair is pulled in a direction away from the skin, to induce tension in the hair, and thus improve the transmission of the vibrations to the hair base. In accordance with a preferred embodiment, the apparatus is designed such that after gripping the hair, and prior to the onset of vibrations, the hair gripping device moves away from the skin, or the skin is pressed in the direction away from the direction of the hair growth, to cause a hair tensioning state with a displacement sufficient to somewhat tension the hair, but to an extent such that would not be painful. In order to determine appropriate tension, the hair-gripping device may be associated with a tension sensor connected to the apparatus' control unit. In

accordance with the above-preferred embodiment, vibrations are induced only after the gripping device reaches a position where the hair is tensioned (determined by the tension sensor).

In accordance with another embodiment, the hair is tensioned prior to gripping the hair, which may be by various means such as by the use of topical preparations with this effect and others.

In accordance with one embodiment, at the end of the hair removal cycle after the vibrations were applied, the hair is released while in accordance with another embodiment, the gripping device pulls the hair further away from the skin, to a hair plucking state whereby the hair is plucked. One should note, however, that given the fact that due to the vibration the connection between the hair root and the surrounding tissue is severely impaired (i.e. disconnected), the plucking is relatively painless, as compared to prior art, plucking-based depilatory devices.

The mechanism by which the gripped hair is stretched initially to the hair tensioning state and then subsequently to the hair plucking state, can vary and depends on the type of gripping device used. Where, for example, the hair-gripping device comprises a spring coil (where the hairs are gripped between adjacent wires) or a gripping device comprising pairs of rotating discs, the different states may be achieved by rotation of the gripping device. Unlike prior art depilatory devices employing such gripping devices, the rotation is temporarily halted when reaching the hair tensioning state to allow the transmission of vibrations. Where, for example, the gripping device comprises fingers which converge or close to grip the hair or to comb-like elements which move one against the other to grip the hair, the different states may be achieved by displacement of the gripping device in a direction normal to the skin.

The vibrations generator may, by one embodiment, operate continuously or, in accordance with another embodiment, may operate intermittently to provide a burst of several vibration pulses in each hair removal cycle.

In accordance with one preferred embodiment, prior to gripping the hair and applying the vibrations, the portion of the skin which includes the hair to be

removed is stretched or stabilized, so as to provide some biasing resistance to the vibrations and limit the dampening effect which may result from some vibration energy being transferred to the skin. This, stretching of the skin may increase the efficiency of the hair removal procedure. In addition, such stretching may also provide a further decrease in the pain associated with the hair removal. In accordance with this preferred embodiment, the skin at the said portion is typically maintained in a stretched state during the period of application of the vibrations. In accordance with this embodiment, the hair removal device comprises one or more skin-stretching elements associated with the gripping device.

Typically, the skin stretching or stabilizing element is a rigid or semi-rigid member, which come into contact with a region of the skin immediately adjacent to the regions of skin from which hair is to be removed. Typically, said elements are positioned on at least two sides of the hair gripping devices, and arranged such so as to provide a stretching force. At times this may be a single such element surrounding the hair gripping device, and presses against the skin to provide the stretching force.

The vibration parameters such as frequency, amplitude, duration of application of vibrations onto the treated hair, direction of vibrations (axial or lateral), angle of extension of hair, extent of pulling of the hair, may all be geared to meet specific requirements, which may depend on physiological parameters of the hair and the treated body zone, as well as to the final desired effect, e.g. temporary or long term to permanent hair removal. In skin regions, which are sensitive to pain, such as the upper lip, the parameters may be tuned, for example, by increasing frequency so as to limit the nerve sensation, thus reducing potential pain. If a longer lasting result, e.g. a permanent cessation of hair growth, is desired, the parameters may be tuned to ensure sufficient damage to hair supporting elements before the hair removal, for example, by the use of a low intensity vibrations for a more extended period of time. The apparatus of the invention may be designed for specific uses, e.g. apparatus for sensitive skin, one apparatus for less sensitive skin, e.g. for the legs, etc., or may at times be provided with a user control interface,

forming part of the control unit to allow to adjust the operation parameters for different types of skin and/or different desired final effects.

The amplitude of vibrations may be in the range of tens to hundreds of μM in the case of a piezoelectric device and hundreds of microns to a few millimeters for other vibration generators. The power of the vibrations as applied to the hair (only a fraction eventually reaching the hair root) are typically within the range of 1 mW to 500 W, preferably in the range of 100 mW to 100 W, most preferably within the range of 1 to 20 W.

The vibrations should be transferred to the hair for a time sufficient to allow transfer of sufficient energy to cause tissue damage in the hair's base or in at least one hair supporting element. Typically, the vibrations are maintained for a period of 0.001 msec to 100 sec, preferably within the range of 0.1 msec to 1 sec, most preferably within the rang eof 1 to 100 msec.

The skin to be treated may be subjected to a pre-treatment, for example, by applying alcohol or detergents, so as to remove oil or debris located between the hair shafts and the surrounding follicle. The cleaning allows the applied vibrations to be transmitted to the roots with less attenuation, which may be caused by the oil or debris. Other pre-treatment procedures may include application of topical anesthesia: heating or cooling of skin regions to be treated; application of various ointments or oils to soften the skin or to increase the size of the opening of the hair follicles; applications of gels or ointments which cause the hair to erect; etc.

In order to understand the invention and to see how it may be carried out in practice, preferred embodiments will now be described, by way of non-limiting example only, with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an embodiment of a hair removal apparatus in accordance with the present invention.

Fig. 2A is an embodiment of a gripping device in accordance with an embodiment of the invention.

Figs. 2B-2E are longitudinal cross-sections through lines II-II in Fig. 2A showing the gripping devices of Fig. 2A in several operational steps.

Fig. 3A shows another embodiment of a gripping device in accordance with the invention.

Fig. 3B-3D are cross-sectional views through lines III-III in Fig. 3A, in these different operational steps.

Figs. 4A and **4B** show an embodiment of a gripping device associated with a skin stretching device, in two operational steps.

Figs. 5A and **5B** show another embodiment of a combined gripping device and skin-stretching device.

Fig. 6 shows a skin portion from where hair was removed using a device operative in accordance with the invention.

DETAILED DESCRIPTION OF THE INVENTION

Fig. 1 shows a schematic illustration of a hair removal apparatus **10** operative in accordance with an embodiment of the invention. The apparatus comprises a main unit **12** encased within a housing **14** and a power unit **16** consisting of a control unit **18** with a mains connector **20** and a signal producing unit **22**, composed of generator and amplifier. Included within the main unit **12** is a gripping device holding rod **30** being engaged at its rear end by a spring **32** and holding at its front end a gripping device **34**. Further comprised within main unit **12** is an electromagnetic coil **36** associated with a power-transmitting rod **38**. It should be noted that a vibration generator based on an electromagnetic device is but an example and rather than electromagnetic coil, other vibration generators such as a piezo-electric device and others may be used instead in other embodiments of the invention. The displacement of rod **38** is controlled by coil **36** and under an alternating current it vibrates axially.

Rod **38** is pivotally linked at **39** to vibration transmission lever **40**, which is in turn pivotally linked at **42** to rod **30**. Lever **40** has a pivot member **44** through

which it is pivotally linked at **46** to casing **14**. Thus, in consequence to this pivoting association, a downward movement of rod **38** in direction of arrow **50** causes an upward movement of rod **30** in the direction of arrow **52** and vice-versa. Spring **32** vibrates in resonance with the rod and thus the reciprocating vibrations of rod **38** affected by coil **36**, bring to reciprocating axial vibrations in rod **30**.

The hair gripping device **34** is surrounded by a spacer **60** which has a skin facing end **64** which serves as a skin stretching element to stretch the underlying skin during operation. Gripping device **34** is associated with a tension sensor **70**, the output of which is fed to control unit **18**, which measures tension and thus permits the controlling element **18** to determine whether hair is gripped by the gripping device **34**.

In the beginning of operation, rod **30** is moved downwards (by pulling rod **38** upwards with coil **36**) whereby gripping device opens the gripped hair and then moved slowly in the reverse direction until sensor **70** determines that a hair is gripped and tensioned. If the output of tension sensor **70** indicates that no hair is gripped, vibrations are subsequently not induced. The degree of lateral displacement is measured by means of a sensor **70** connected to a control unit **18**. Sensor **70** with associated feedback loops allows to adequately control the frequency and intensity of the vibrations transmitted to the hair.

Displacement-limiting unit **62** provides a mechanical limit for the displacement of spacer **60** and gripping device **34**, moved by rod **30** and also has an has a mechanical limit and has a sensor **72** controlling and limiting the displacement in the reverse direction to prevent accidental plucking. In case of extra displacement sensor **72** may give a signal to unit **18** to prevent activation of the apparatus. At times of applying vibrations, distal face **64** of spacer **60**, is in touch and stretches the skin to dampen skin vibrations.

Vibrations induced by signal producing unit **22** which conveniently has frequency equal to the mains current input or a certain frequency multiplication thereof is then generated and amplified to the proper level by unit **22** and the

current is then transmitted to coil **36**. Thus, vibrations at a controlled amplitude and frequency are transmitted to hair gripped by gripping device **34**.

The vibrations are applied for a certain amount of time, and then rod **30** with gripping device **34** is lowered, whereby gripping device opens and releases the hair.

In other embodiments of the invention, it is possible also at the end of the vibration step to pull rod **52** upwards, thereby plucking the hair which may then be subsequently released.

Fig. 2A shows an embodiment of a hair gripping device **100** in accordance with an embodiment of the invention. Gripping device **100** situated at the end of stem **102**, which may be an integral extension of rod **52** in Fig. 1, has a head portion **104** consisting, in this specific example, of seven diverging leaves **106** integrally extending from stem **102**. Hair gripping device **100** further comprises a sleeve **110** which can move axially in the reverse direction towards the distal end of head portion **104** to converge leaves **106** or move in the reverse direction to release the head portion **104** and causes the leaves to diverge again. Sleeve **110** has two oppositely situated lateral cuts **112** which allow hair to enter the spaces between leaves **106**.

The manner of operation of this gripping device can be seen in Figs. 2B-2E, which are cross-section through lines II-II of fig 2A at several consecutive steps of operation. At the initial stage, described in fig 2B, sleeve 110 is located at its initial place (as in Fig. 2A). After attachment to the skin, hair 113 becomes located in space between leaves 106. As seen in Fig. 2B, sleeve **110** is moved downward in the direction of arrow **112**, thereby bringing to conversion of leaves **106** which thus grip hair **113** in the space between them. After the hair **113** is gripped, as seen in Fig. 2C, stem **102** with the gripping device is moved upwards, in the direction of arrow **114**, with head portion **104** remaining in a converged state (with the sleeve **110** remaining in the relative downward position visibly head **104**), bringing to tensioning of hair **113**. Then, as represented in step Fig. 2D, stem **102** is vibrated, (while sleeve **110** is still placed downwards) represented by wavy

arrow **115** which destroys the base of hair **113** and subsequently, as shown in Fig 2E, by moving sleeve upwards **110** leaves **106** open, releasing treated hair **113**, (in Fig. 2E the hair **113** is shown as being detached from the skin, although at times the hair may still remain temporarily attached to the skin and fall off from the skin subsequently, or the hair may be actively plucked by slightly moving rod **102** upwards in the direction of arrow **114** in Fig 2C, while the hair is still gripped between leaves **106**.

Another embodiment of a hair-gripping device **200** is shown in Fig. 3A. It comprises a thin rod **202** at a distal end of stem **204**, which forms the distal of the power transmission rod of the apparatus, such as rod **52** in Fig. 1. Rod **202** holds on it a flexible spring member **205** having a ring portion **206** engulfing a distal end of rod **202** and two springy arms **208** and **210**, having each essentially V-shaped projecting portion **212** and **214**, respectively, a straight section **216** and **218**, respectively, biased and tightly held against the face of the distal portion **224** of rod **202** and diverging distal ends **220** and **222**, respectively.

Figs 3B-3D show cross-sections through lines III-III in Fig. 3A in several consecutive operational steps. In Fig 3B, which is the state seen in Fig. 3A, straight portion **216** and **218** are tightly attached to rod **202**. By providing pressure on V-shaped portions **212** and **214**, in the direction of arrows **230**, as seen in Fig. 3C, portions **216** and **218** diverge from their initial state to a diverging state shown in Fig. 3C and the tip of hair **231** guided by diverging portions **220** and **222** enters into the space **232** formed between portions **216** and **218** and distal portion **224** of rod **202** and after the pressure on portions **212** to **214** (Fig. 3D) is released, hair is caught. Pressure onto V-shaped portions **212** and **214** may be applied by means of a sleeve, similar to sleeve **110**, in Fig. 2A or any other suitable means to produce a mechanical pressure.

An apparatus employing a gripping device of the embodiment shown in Figs. 2A or 3A can have a single gripping device or can be provided with an array of such gripping devices.

Figs. 4A and 4B illustrate an embodiment in which a gripping device is combined with a skin-stretching device. This combination is shown in an initial state in Fig. 4A and in an operational state in Fig. 4B. The gripping device/skin stretching device combination **300** (hereinafter "*the combination device*") comprises a hair brush-type gripping device **302** at a distal end of a rod **303** having outwardly diverging grooves **304** adapted to "*catch*" hair trapped in them. The combination device **300** comprises a skin stretching device **306** consisting of three skin stretching arms **308**, **310** and **312**.

Arms **308**, **310** and **312** are pivotally attached to a base structure **314** and can pivot between a closed state shown in Fig. 4A and an open state shown in Fig. 4B. Base structure has a central opening **316** accommodating rod **303**.

Rod **303**, which may be an end portion of a rod such as rod **30** of Fig. 1, can be pulled upward through an opening **316** between an extended state shown in Fig. 4A and a retracted state shown in Fig. 4B. By such movement, hair which is gripped by gripping device **302** is stretched and at the same time gripping device **302** causes skin stretching arms to diverge into the state shown in Fig. 4B stretching the skin below. At the end of the process, rod **303** is moved downwards towards skin and skin stretching arm **308**, **310** and **312** converge to release skin tension.

A hair gripping device/skin stretching element combination **400** in accordance with another embodiment of the invention is shown in Figs. 5A and 5B. The combination device 400 comprises a hair gripping device **402** consisting of two comb-like members **404** and **406** (can best be discerned from one another in Fig. 5B) which can move slightly sideways one versus the other in the direction of the bi-directional arrow **410** in Fig. 5A, thus allowing gripping of hair which is trapped in the grooves **411** defined in device **402** in the state shown in Fig. 5A.

Combination **400** further comprises a skin support and stretching element **412**, which has diverging projections **414**. In use, the apparatus is moved such that combination **400** advances in the direction represented by arrow **420**, with

element **412** being pressed against the skin, and thus hair is guided by projections **414** to be trapped within grooves **411** of member **402.**

After the relative position of units **404** and **406** is laterally shifted to the state shown in Fig. 5B, shaft **432,** which may be an integral extension of a rod such as rod **30** in Fig. 1, is pulled away from the skin in the direction of arrow **434** in Fig. 5B to reach a state as in Fig. 5B, in which the gripped hair are tensioned and the skin is leveled and stretched by skin stretching element **412.** Stopper 430 prevents extra movement in this direction. At the end of the operation the relative lateral position of units **404** and **406** is changed to their position in Fig. 5A, thereby hair is released.

EXAMPLE

Experimental procedure

The apparatus used according to this non-limiting example was an apparatus of the kind illustrated in Fig. 1 and comprising an electromagnetic vibrator oscillating at 100 Hz. The displacement amplitude was about 0.3 mm, with an intensity of 5 W. The gripping member, situated at the end of a gripping device-holding rod was composed of two parallel plates, that could be alternatively either attached to each other and gripping the hairs or detached and release the hair.

Experimental setup

Three annexed skin zones of volunteer hand were marked. Each zone contained 5 hairs. One zone served as control, the other two zones were experimental zones. with and without stretching the skin. Hairs of one zone, *"zone A"*, were plucked one at a time, using tweezers. The procedure was painful and 2 out of 5 hairs were removed with their roots. Hairs of the second zone,

"zone B", were plucked, one at a time, using the above mentioned prototype of a hair removal device. Skin was not stretched during the operation, and the whole procedure took a fraction of a second, about tenth of a second for each hair. The procedure could be felt, but was not painful, and all hairs were removed with their roots. Hairs of the third zone, *"zone C"*, were plucked one at a time in similar method as described for zone B, with the difference that the skin was stretched using a plastic brush-like device. Also here hair was removed with their roots by applying vibrations for about 100 msec. with the removal being not felt at all. Furthermore the removal was long lasting.

Fig. 6 describes the appearance of the skin surface 8 weeks after the above-mentioned treatment, for each of the three zones. As shown, in zone A- a complete regrowth of all 5 hairs was observed. In zone B - only 2 out of 5 hairs showed minor regrowth with cessation of growth of further 3 out of 5 hairs. In zone C, no regrowth was observed, i.e., cessation of growth was complete. The experiment was repeated and results were the same, i.e., full regrowth with regular plucking, partial regrowth with removing hair with the said prototype without stretching the skin, and cessation of growth after using the device with stretching the skin.

CLAIMS:

1. A hair removal method comprising:

(i) gripping hair to be removed;

(ii) transferring, to the gripped hair vibrations, at a frequency and amplitude, such that the vibrations are transmitted to the hair's root and exert a tissue-damaging effect in said root and/or in at least one hair supporting element.

(iii) maintaining said vibrations for a time sufficient to bring the hair's roots to disconnect from the hair supporting elements and/or to disconnect the hair supporting elements from the surrounding tissue; and

(iv) releasing the said hair.

2. A method according to claim 1, comprising the following step after step (a):

(a1) tensioning the hair.

3. A method according to Claim 1, comprising the following step before step (a):

(a0) tensioning the hair.

4. A method according to Claim 2, wherein the hair is extended at an angle which is essentially perpendicular to the skin.

5. A method according to claim 1, wherein the tissue damaging force causes temporary destruction of the hair root and/or of at least one hair supporting element.

6. A method according to claim 1, wherein the tissue damaging force causes permanent destruction of the hair root and/or of at least one hair supporting element.

7. A method according to Claim 1, wherein said frequency is larger than about 10 Hz.

8. A method according to Claim 1, wherein the vibrations have amplitude of more than 20 microns.

9. A method according to any one of the preceding claims, wherein said vibrations are maintained for a period of at least 10 msec.

10. A method according to any one of the preceding claims, comprising the following additional step (d1):

(d1) pulling the hair out of the skin.

11. A method according to Claim 10, wherein the step of pulling the hair out of the skin is before the step of releasing the hair.

12. A method according to Claim 8, comprising the additional step after step (d1):

(d2) pulling the follicle , which is optionally attached to the hair, out of the skin.

13. A method according to any one of the preceding claims, comprising the following additional step prior or during step (b);

(b1) stretching a portion of the skin that includes the hair to be removed.

14. A method according to any one of the preceding claims wherein prior to gripping the hair, the skin portion that includes the hair to be removed is cleaned of dirt and oil debris.

15. A method according to any one of the preceding claims wherein prior to or during step (d), the temperature or skin portion that includes the hair to be removed, is altered.

16. A method according to any one of the preceding claims wherein prior to gripping the hair, a gel causing hair to erect is applied onto the skin portion from which hair is to be removed.

17. A hair removal device, operating through hair removal cycles, wherein each cycle starts with a gripping of the hair to be removed and ends with the release of said hair, the device comprising:

(i) a hair gripping device for gripping to hair at a start of the hair removal cycle and releasing the hair at the end of a hair removal cycle;and

(ii) a vibration generator coupled to the gripping device , for transmitting vibrations to the hair through said gripping device during said cycle; said vibrations being at a frequency and amplitude such that they are transmitted to the hair's root and/or to at least one hair supporting element and to gives rise thereto a tissue damaging effect.

18. A device according to Claim 17, wherein said gripping device has a first, hair gripping position and a second, hair releasing position, said device being in said first position at the beginning of said cycle gripping the hair to be removed, and moving to the second position at the end of said cycle releasing the hair.

19. A device according to Claim 18, wherein said gripping device has said first gripping position, an intermediate hair-tensioning position and said second, hair releasing position; in said intermediate position, the gripped hair is tensioned.

20. A device according to Claim 18 or 19, wherein after moving to the second position at the end of the cycle, the device reverts to the first hair gripping position.

21. A device according to Claim 17, further comprising a skin stretching element.

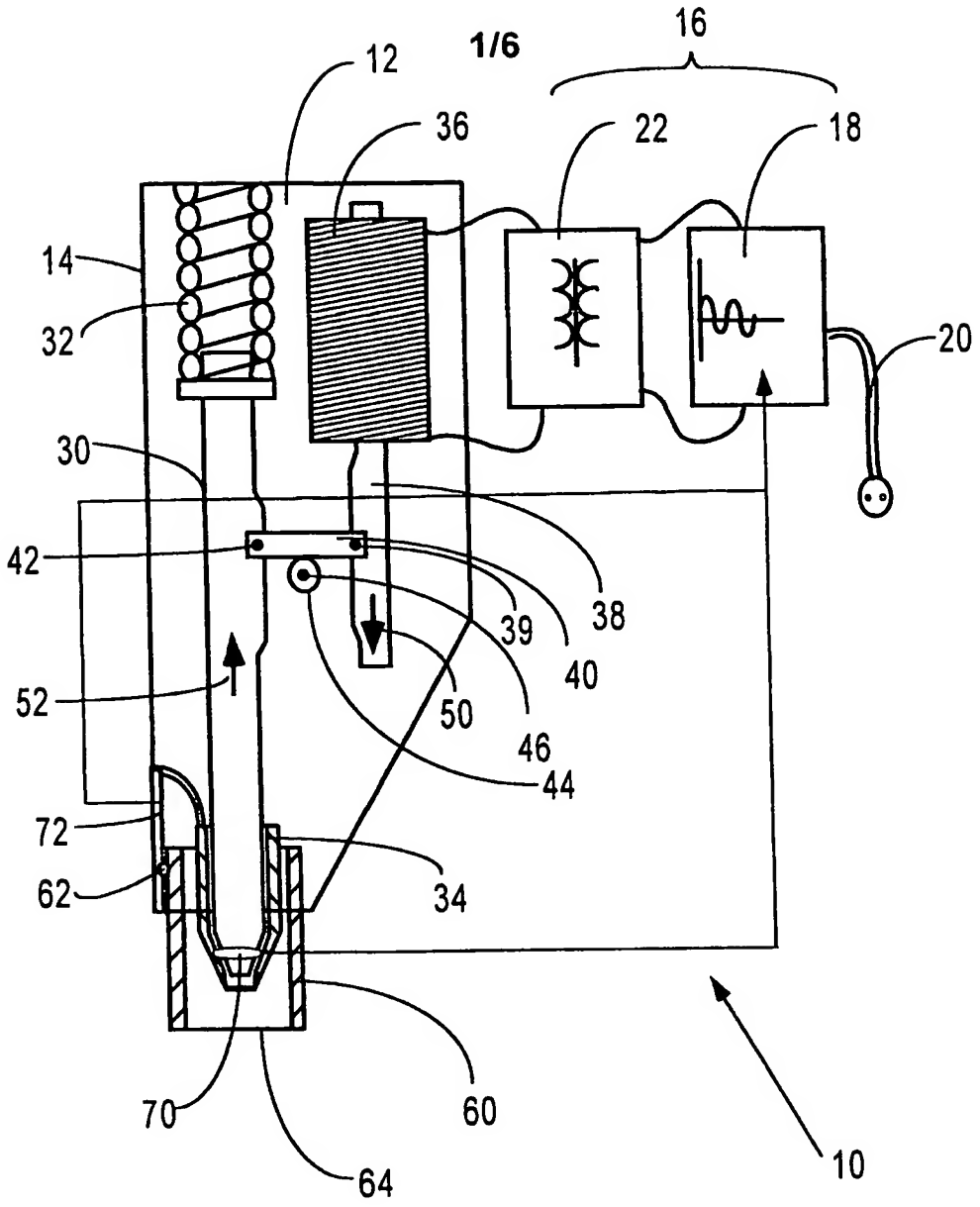

Fig. 1

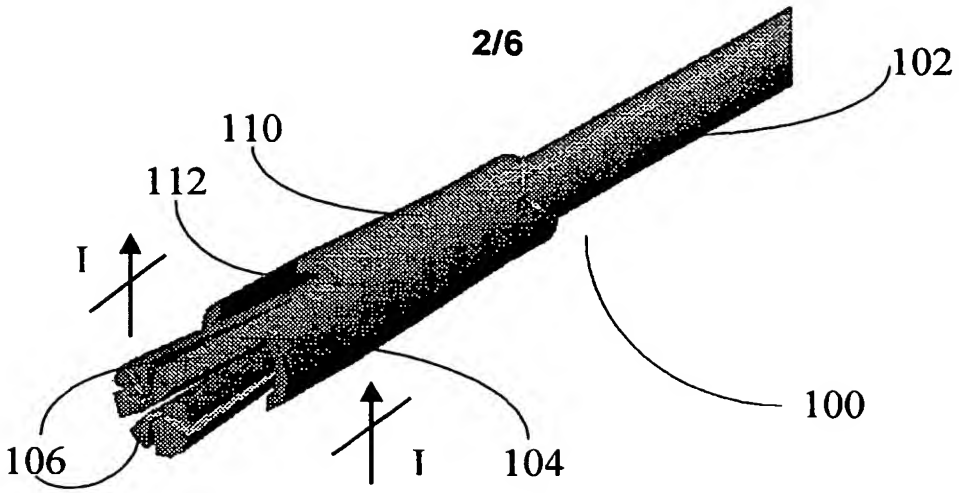

Fig. 2A

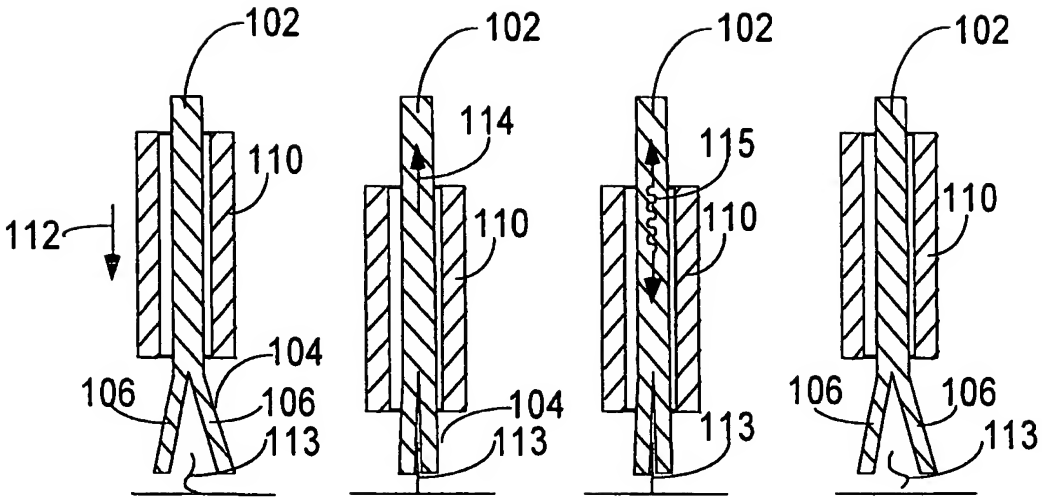

Fig. 2B Fig. 2C Fig. 2D Fig. 2E

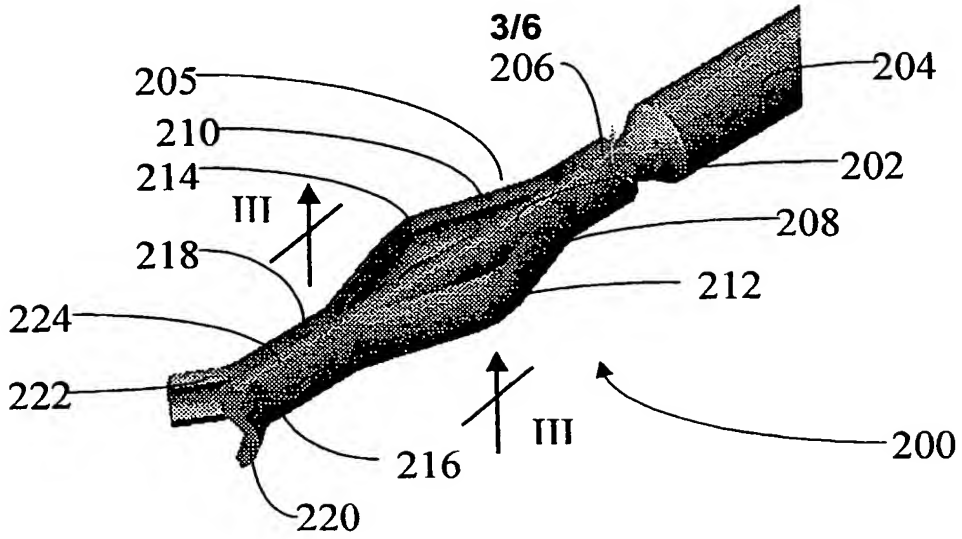

Fig.3A

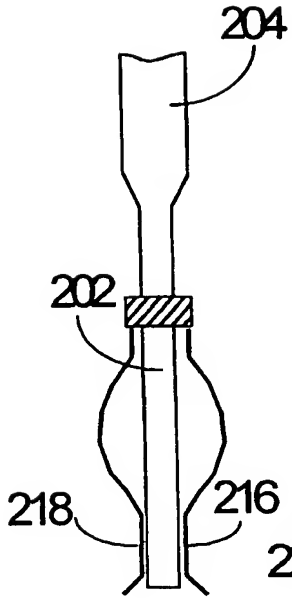

Fig. 3B

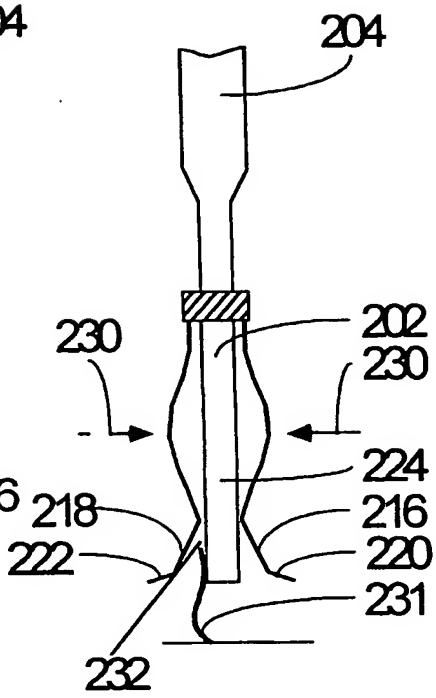

Fig. 3C

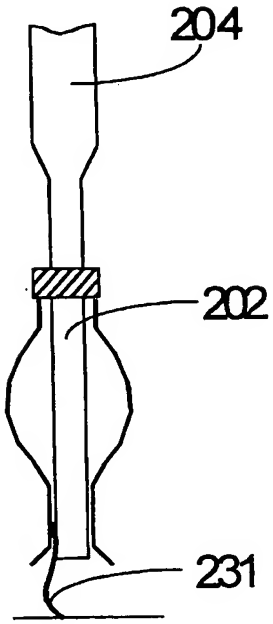

Fig. 3D

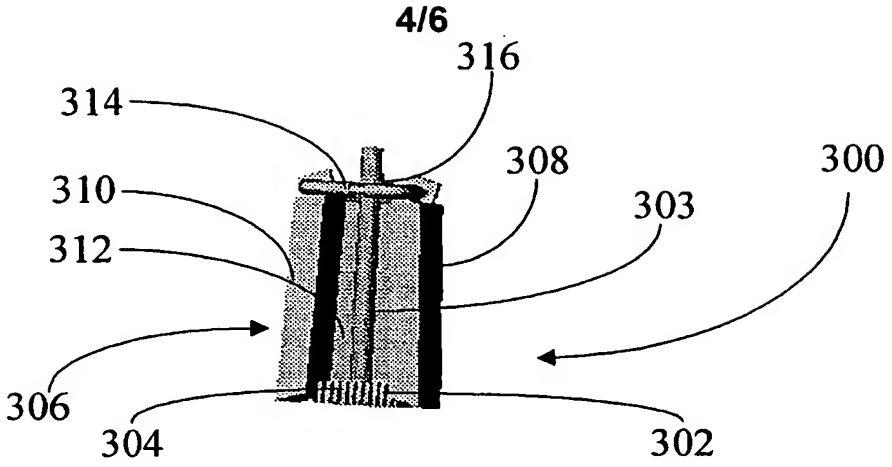
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Fig.4A

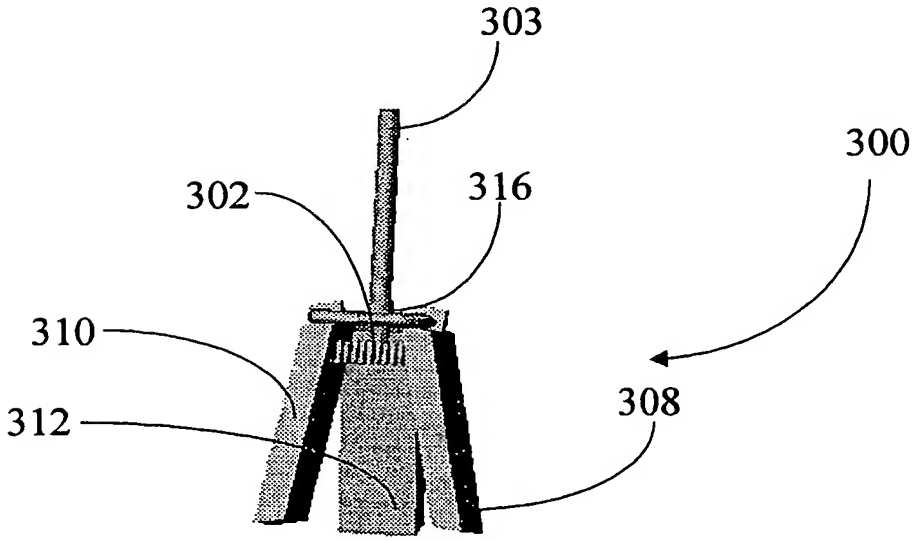
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Fig.4B

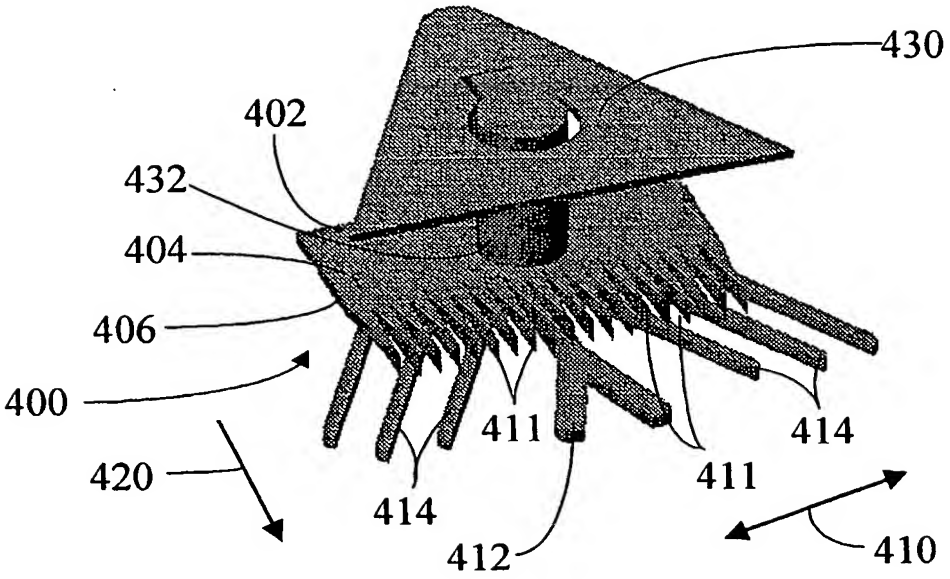
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Fig. 5A

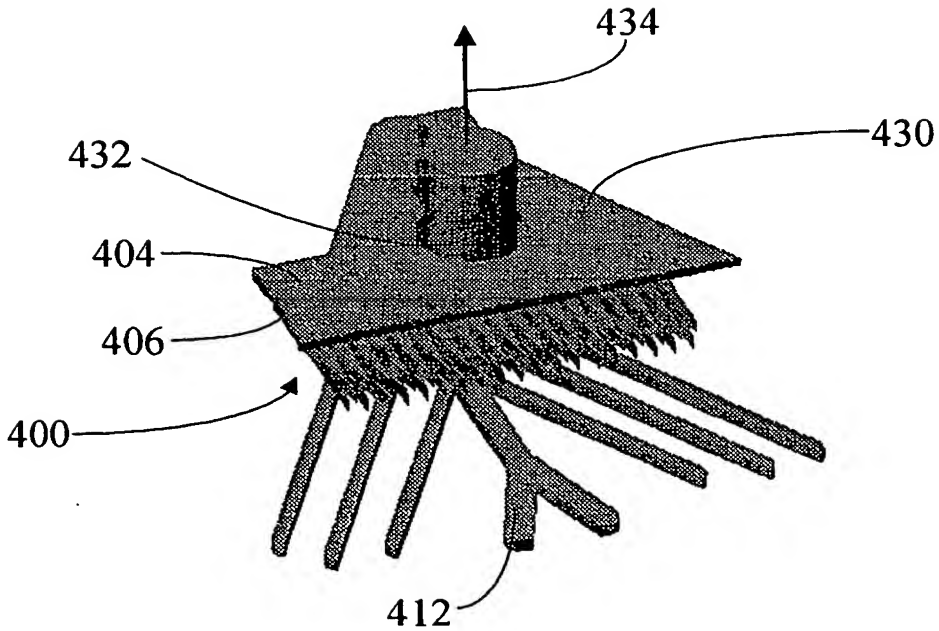
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Fig. 5

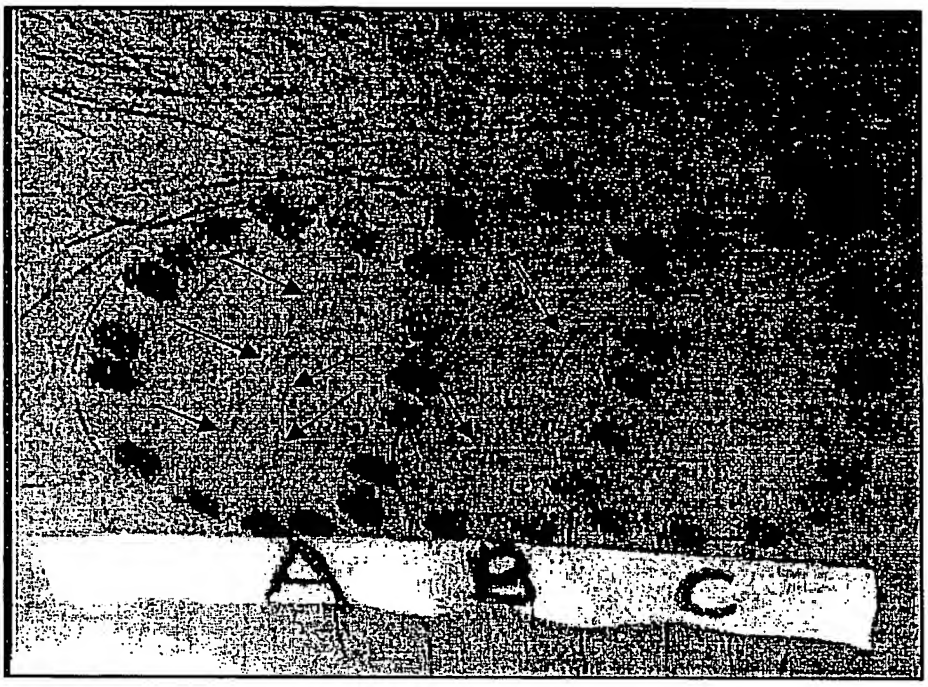

Fig. 6

INTERNATIONAL SEARCH REPORT

Interr nal Application No
PCT/IL 00/00507

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A45D26/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A45D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
PAJ, EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 015, no. 048 (C-0802), 5 February 1991 (1991-02-05) & JP 02 279107 A (HOOMAA ION KENKYUSHO:KK), 15 November 1990 (1990-11-15) abstract ---	1,4-7, 10-12,17
X	PATENT ABSTRACTS OF JAPAN vol. 1996, no. 03, 29 March 1996 (1996-03-29) & JP 07 298921 A (JAPAN FITNESS:KK;OTHERS: 01), 14 November 1995 (1995-11-14) abstract --- -/--	1,4-7, 10,12,17

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 January 2001	25/01/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Sigwalt, C

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INTERNATIONAL SEARCH REPORT

Interr nal Application No
PCT/IL 00/00507

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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